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The Emittance Absorber for the MuCool Beamline*

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Abstract

The MuCool Test Area (MTA) is an intense primary beam facility derived directly from the Fermilab Linac to test heat deposition and other technical concerns associated with the liquid hydrogen targets, gas-filled rf cavities, and other apparatus being developed to cool intense, large-emittance muon beams. In addition, the beamline design incorporates a specialized insertion for beam diagnostics which allows another mode of operation, the emittance mode, to be established which will provide detailed measurements of Linac beam properties This note discusses the emittance beam absorber for the emittance mode of operation of the MuCool beamline.

1 Introduction

The MTA facility was designed to test targets and other muon cooling apparatus using the intense Fermilab Linac beam. The requested intensity of the proton beam for the MTA is essentially full Linac capability [1], or 1.6×10^{13} protons per pulse and an energy of 400 MeV. . In addition, the beamline design incorporates a specialized insertion for beam diagnostics. This specialized insertion allows another mode of operation, or beamline tune, to be established which will provide detailed measurements of Linac beam properties, greatly enhancing the functionality of this line, and supplying valuable information about accelerator operation. Therefore two modes of operation are supported in the MuCOOL beamline: one mode for emittance measurements (and beamline studies) and a second mode for MTA experiments. Maximum beam intensity for these two modes is: 9.6×10^{15} protons/hr – 600 beam pulses/hour of full Linac beam pulse intensity (1.6×10^{13} protons/pulse) to the emittance beam absorber and 9.6×10^{14} protons/hour – 60 pulse beam pulses/hour of full Linac beam pulse intensity to experiments in the MTA experimental hall. In the emittance mode the full MuCool beam is always deposited in the emittance beam absorber. This note describes the construction and MARS simulations regarding the emittance beam absorber; i.e. prompt dose and star densities.

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2 The Emittance Absorber

The emittance absorber is installed at the end of the MuCool beamline stub, a 10'x10' prefabricated concrete enclosure. The end of the stub and thus the location of the emittance absorber is approximately 147' from the point of extraction from the Fermilab Linac and there is a 2.5' step down from this stub into the MTA experimental hall. The emittance beam absorber is 6" inches in diameter and 26" long. The first 8" in length is composed from copper for efficient heat absorption and distribution followed by 18" of steel.

The emittance absorber was modeled using the MARS15 code [1] to predict prompt radiation dose and star densities for ground and surface water activation. Fragments of the geometry model as shown use the following color scheme to denote materials: white, light blue, green and grey colors correspond to vacuum, air, soil and regular concrete, respectively. The meaning of the other colors can vary depending on materials used in the system under consideration. It should be taken into account also that boundaries between different regions are shown with black lines. When the resolution of the figure is inadequate, small regions sometimes are not distinguishable and appear as black regions.

2.1 Emittance Mode Results for the Emittance Absorber

The geometry of the emittance absorber used for the MARS simulation is shown in Figure 1. The results for star density and prompt dose are shown in Figures 2 and 3.

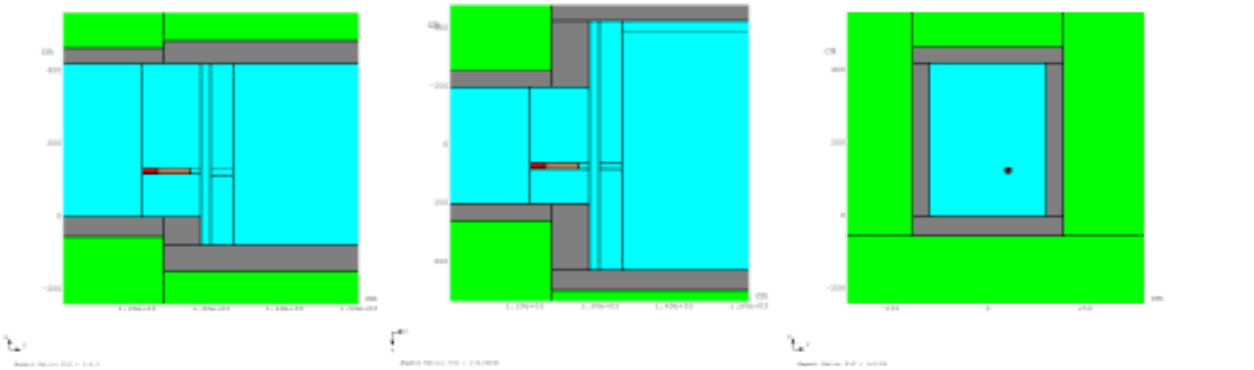

Figure 2. The MARS model of the emittance absorber for profile (left), plan (middle), and downstream (right) views.

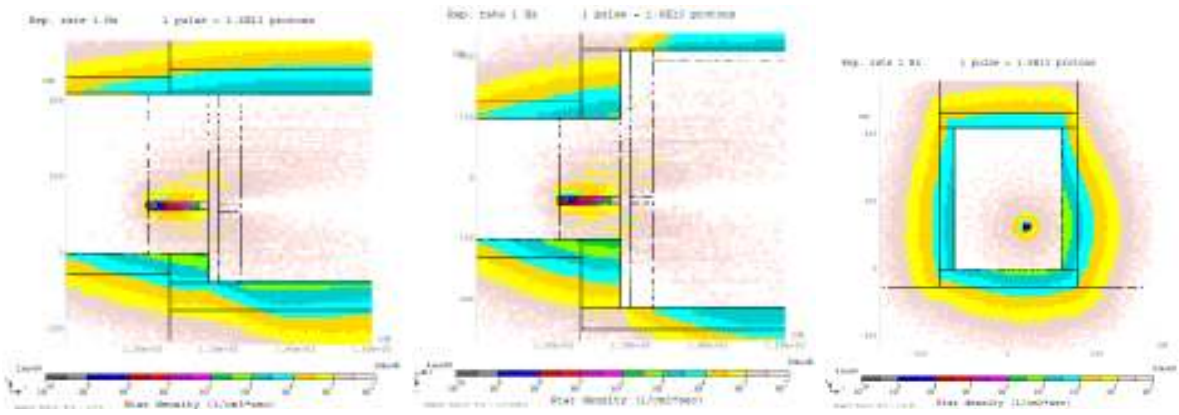

Figure 2. The corresponding MARS results for the star density for profile, plan and downstream views (left to right).

The results for the emittance absorber for emittance mode indicate a maximum star density of about 10^4 stars/(cm3*sec). The prompt dose results shown in Figure 3 gives a maximum of 17 mrem/hour at the top of berm.

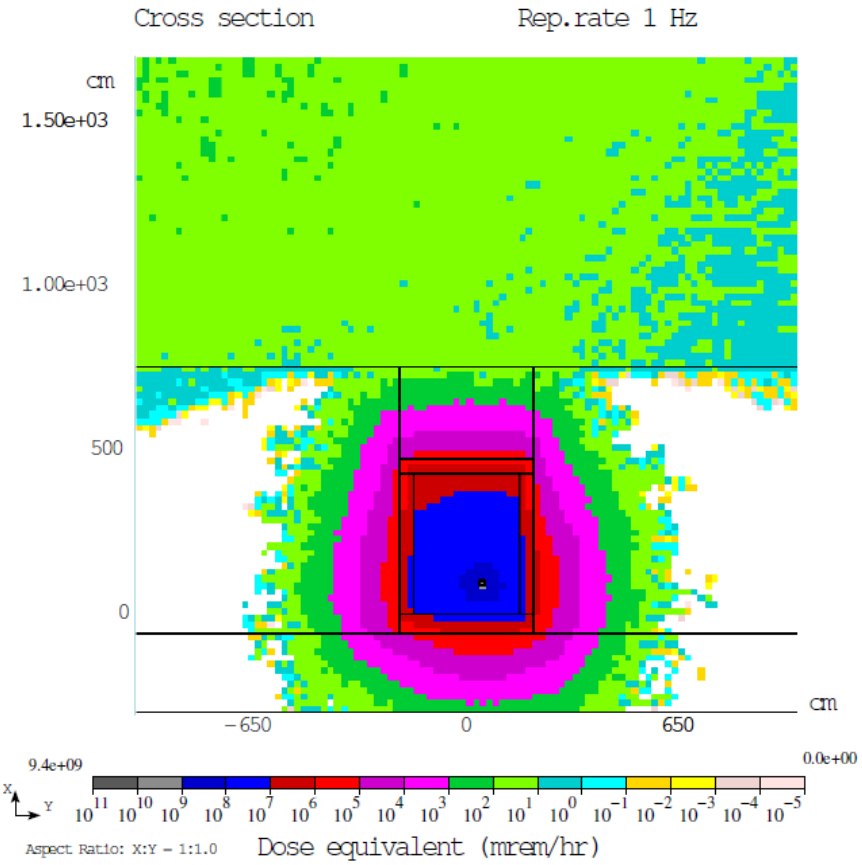

Figure 3. The corresponding MARS results for the prompt dose for the emittance absorber in the emittance mode of operation.

References

[1] N.V. Mokhov, “The MARS Code System User’s Guide”, Fermilab-FN-628 (1995); N. V. Mokhov, S. I. Striganov, “MARS15 overview,” Proc. Hadronic Shower Simulation Workshop, Batavia, Illinois, USA, 6-8 September, 2006, Vol. 896, pp. 50-60, American Institute of Physics, Melville, NY (2007); http://www-ap.fnal.gov/MARS/
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